

CLAIMS

What is claimed is:

- 5 1. An acoustic sensor, comprising:
 a base;
 a microphone supported by the base, the microphone including a
microphone diaphragm; and
 a hot-wire anemometer supported by the base, the hot-wire anemometer
10 including a set of hot-wire extending members that defines a plane which is
substantially parallel to the microphone diaphragm.
2. The acoustic sensor of claim 1 wherein a first layer of conductive material defines
the microphone diaphragm, wherein a second layer of conductive material defines
15 the set of hot-wire extending members, and wherein the base includes a substrate
that supports both the first layer of conductive material and the second layer of
conductive material.
3. The acoustic sensor of claim 2 wherein the microphone further includes:
20 a rigid member that is supported by the base and that is substantially
parallel to the microphone diaphragm to define a condenser microphone cavity,
wherein a third layer of conductive material defines the rigid member of the
microphone, wherein the substrate supports the third layer of conductive material,
and wherein the microphone diaphragm extends in a contiguous manner to the
25 base to form a seal between the set of hot-wire extending members and the
condenser microphone cavity.

4. The acoustic sensor of claim 2 wherein the set of hot-wire extending members includes:

tungsten bridges that are substantially parallel to each other within the plane defined by the set of hot-wire extending members.

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5. The acoustic sensor of claim 2, further comprising:

a layer of protective material supported by the substrate, the layer of protective material defining a mesh such that sound waves are capable of passing from an external location to the set of hot-wire extending members and to the microphone diaphragm through the layer of protective material.

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6. The acoustic sensor of claim 2 wherein the first layer of conductive material defines multiple microphone diaphragms including the microphone diaphragm, wherein the multiple microphone diaphragms are configured into a two-dimensional $N \times M$ array of microphone diaphragms, wherein the second layer of conductive material defines multiple sets of hot-wire extending members including the set of hot-wire extending members, and wherein the multiple sets of hot-wire extending members are configured into a two-dimensional $N \times M$ array of sets of hot-wire extending members that corresponds to the two-dimensional $N \times M$ array of microphone diaphragms.

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7. The acoustic sensor of claim 6 wherein the two-dimensional $N \times M$ array of microphone diaphragms includes:

a first microphone diaphragm configured to respond to sound waves within a first frequency range; and

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a second microphone diaphragm configured to respond to sound waves within a second frequency range that is different than the first frequency range.

8. The acoustic sensor of claim 6 wherein the two-dimensional N x M array of microphone diaphragms includes a first row of microphone diaphragms configured to respond to sound waves within a first frequency range, and a second row of microphone diaphragms configured to respond to sound waves within a second frequency range that is different than the first frequency range.
9. An acoustic system, comprising:
- an acoustic sensor having (i) a base, (ii) a microphone having a microphone diaphragm that is supported by the base, and (iii) a hot-wire anemometer having a set of hot-wire extending members that is supported by the base, the set of hot-wire extending members defining a plane which is substantially parallel to the microphone diaphragm; and
 - a processing circuit that receives a sound and wind pressure signal from the microphone and a wind velocity signal from the hot-wire anemometer, and that provides an output signal based on the sound and wind pressure signal from the microphone and the wind velocity signal from the hot-wire anemometer.
10. The acoustic system of claim 9 wherein the acoustic sensor is a microelectromechanical systems device, wherein a first layer of conductive material defines the microphone diaphragm, wherein a second layer of conductive material defines the set of hot-wire extending members, and wherein the base includes a substrate that supports both the first layer of conductive material and the second layer of conductive material.

11. The acoustic system of claim 10 wherein the microphone of the acoustic sensor further includes:
- 5 a rigid member that is substantially parallel to the microphone diaphragm to form a condenser microphone cavity, wherein a third layer of conductive material defines the rigid member of the microphone, wherein the substrate supports the third layer of conductive material, and wherein the microphone diaphragm extends in a contiguous manner to the base to form a seal between the set of hot-wire extending members and the condenser microphone cavity.
- 10 12. The acoustic system of claim 10 wherein the set of hot-wire extending members of the hot-wire anemometer of the acoustic sensor includes:
- tungsten bridges that are substantially parallel to each other within the plane defined by the set of hot-wire extending members.
- 15 13. The acoustic system of claim 10 wherein the acoustic sensor further includes:
- a layer of protective material supported by the substrate, the layer of protective material defining a mesh such that sound waves are capable of passing from an external location to the set of hot-wire extending members and to the microphone diaphragm through the layer of protective material.
- 20 14. The acoustic system of claim 10 wherein the first layer of conductive material defines multiple microphone diaphragms including the microphone diaphragm, wherein the multiple microphone diaphragms are configured into a two-dimensional $N \times M$ array of microphone diaphragms, wherein the second
- 25 layer of conductive material defines multiple sets of hot-wire extending members including the set of hot-wire extending members, and wherein the multiple sets of hot-wire extending members are configured into a two-dimensional $N \times M$ array of sets of hot-wire extending members that corresponds to the two-dimensional $N \times M$ array of microphone diaphragms.

15. The acoustic system of claim 14 wherein the two-dimensional N x M array of microphone diaphragms includes:
- 5 a first microphone diaphragm configured to respond to sound waves within a first frequency range; and
- a second microphone diaphragm configured to respond to sound waves within a second frequency range that is different than the first frequency range.
- 10 16. The acoustic system of claim 14 wherein the two-dimensional N x M array of microphone diaphragms includes a first row of microphone diaphragms configured to respond to sound waves within a first frequency range, and a second row of microphone diaphragms configured to respond to sound waves within a second frequency range that is different than the first frequency range.
- 15 17. The acoustic system of claim 9 wherein the processing circuit includes:
- a conversion stage that converts the wind velocity signal from the hot-wire anemometer into an analog wind pressure signal having a wind pressure component; and
- 20 an output stage that subtracts the wind pressure component of the analog wind pressure signal from the sound and wind pressure signal from the microphone to provide the output signal.
18. The acoustic system of claim 17 wherein the conversion and output stages are analog circuits which reside in an application specific integrated circuit.
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19. The acoustic system of claim 9 wherein the processing circuit includes:
- 5 a correlation stage that digitizes the wind velocity signal, correlates the digitized wind velocity signal with a series of wind pressure values from a lookup table, and provides the series of wind pressure values in the form of a correlation signal; and
- an output stage that (i) receives the correlation signal from the correlation stage, (ii) receives the sound and wind signal from the microphone, and (iii) subtracts the series of wind pressure values from the sound and wind pressure signal to provide the output signal.
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20. A method for providing an acoustic signal, the method comprising the steps of:
- generating a sound and wind pressure signal in response to sound and wind pressure on a microphone diaphragm;
- generating a wind velocity signal in response to wind velocity on a
- 15 hot-wire anemometer having a set of hot-wire extending members that defines a plane which is substantially parallel to the microphone diaphragm; and
- providing, as the acoustic signal, an output signal based on the generated sound and wind pressure signal and the generated wind velocity signal.
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21. The method of claim 20, further comprising the step of:
- providing, as the microphone and the hot-wire anemometer, a microelectromechanical systems device.
22. The method of claim 20 wherein the step of providing the output signal includes
- 25 the step of:
- converting the wind velocity signal into an analog wind pressure signal having a wind pressure component; and
- subtracting the wind pressure component of the analog wind pressure signal from the sound and wind pressure signal to provide the output signal.

23. The method of claim 20 wherein the step of providing the output signal includes the step of:
- digitizing the wind velocity signal;
 - correlating the digitized wind velocity signal with a series of wind pressure values from a lookup table; and
 - subtracting the series of wind pressure values from the sound and wind pressure signal to provide the output signal.
24. A method for making a microelectromechanical systems device, the method comprising the steps of:
- disposing a first layer of material over a base structure;
 - disposing a second layer of material over the first layer of material; and
 - removing at least a portion of the first layer of material and a portion of the second layer of material such that a remainder of the second layer of material forms multiple extending members supported by the base structure, the extending members being parallel to each other, wherein each of the steps of disposing the first layer of material, disposing the second layer of material and removing occurs within a temperature range that is less than 700 degrees Celsius.
25. The method of claim 24 wherein the step of disposing the second layer of material includes the step of:
- depositing, as the second layer of material, conductive material using a plasma enhanced chemical vapor deposition process.
26. The method of claim 25 wherein the step of depositing includes the step of:
- positioning, as the conductive material, tungsten over the first layer of material such that the microelectromechanical systems device is capable of operating as a hot-wire anemometer.

27. The method of claim 24 wherein the base structure includes a substrate, and wherein the method further comprises the step of:
- prior to disposing the first layer of material over the base structure, forming a microphone diaphragm over the substrate of the base structure such that, after the step of removing, the microphone diaphragm resides between the multiple extending members and the substrate.
28. The method of claim 27, further comprising the step of:
- removing a portion of the substrate to form a first portion of a condenser microphone cavity;
- forming a rigid member over another substrate and removing a portion of the other substrate to form a second portion of the condenser microphone cavity; and
- bonding the substrate with the other substrate such that the first and second portions of the condenser microphone cavity align, and such that the microphone diaphragm is disposed between the multiple extending members and the condenser microphone cavity to form, as the microelectromechanical systems device, an acoustic element having a hot-wire anemometer and a condenser microphone.